PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Sound Producing Devices.

Communication from SUBMARINE SIGNAL CORPORATON, a corporation organized under the laws of the State of Delaware, and having its principal place of business at 160, State Street, Boston, Massachusetts, United States of America.

I, WILLIAM JOHN MELLERSH-JACKSON, a subject of the King of Great Britain, of the firm of Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton Buildings, London, W.C. 2, in the County of Middlesex, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My invention relates to a new and useful improvement in sound producing devices and particularly to mechanisms designed to create underwater sounds, although it has other uses. While the present device is capable of producing sounds of any frequency, its design is such as will enable sounds of high frequency to be created without some of the losses of energy inherent in most of the forms heretofore used.

According to this invention the sound producing device comprises a rigid sound emitting member connected at or towards its periphery to one end of a double tube adapted to transmit longitudinal oscillations, the other end of which tube reciprocates by electrodynamic action in a magnetic field. The portion of the oscillator in contact with the medium in which the compressional waves are to be set up is made of relatively great thickness except for a small portion not far from its periphery. This piston-like design ensures that the movements of all points in the greater portion of the area in contact with the water or other medium are equal, and that the movements of each and every portion of the moving surface in contact with the water are exactly in phase.

An important part of the invention is the method of providing the necessary elastic elements. In some of the sound producers heretofore made the required elasticity has been obtained by a coupling between elastic discs and an elastic diaphragm. When such a design is employed in attempts to make an oscillator operating at frequencies of 1000 vibrations or more a second, it is necessary to raise the pitch of the coupled discs and diaphragm by increasing their thickness. Not only is there great difficulty in tuning the elements forming this couple so as to obtain the desired frequency, but there is serious danger of the elastic members being strained beyond their elastic limit. This difficulty has been overcome by depending not upon the transverse elasticity of two or more members, but by the utilization of the longitudinal elasticity of a single member in the form of the double tube described, the thickness and lengths of which can be readily controlled so as to obtain the required frequency of the diaphragm movements without any danger of undue strain upon the elastic member. The weight of the metal piece in contact with the water to which the elastic member is attached is so great that the elasticity of its coupling to the casing can be practically neglected as affecting the frequency of the movements of the elastic member. Sound producers have been previously designed using longitudinal elasticity rather than transverse, but in the present case a distinct improvement is effected by making the elastic member in the form of a double tube. The necessary motion is therefore obtained from one member forming a concentric portion of the entire mechanism. For it is obvious that a single rod attached to the centre of the heavy diaphragm member cannot impart motion to this member, as a whole, without introducing large stresses within the member, whereas with a tube acting near the periphery of the member, the force exerted is so distri-

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buted as to produce a motion of the member as a whole with comparatively small internal stresses.

Another important advantage obtained lies in the fact that the adjustment of the internal working parts of the sound producer is not affected by the differences in pressure exerted upon the sound producing member when the apparatus is immersed at different depths. In no other mechanism, so far as is known, in which the longitudinal vibrations of a rod or its equivalent are used is this most important feature obtained. In this device under ordinary conditions of use the end of the vibrating member having the maximum motion has no restriction to its movement as far as the mechanical arrangements and dimensions are concerned, and the mechanism will work, as far as this feature is concerned, equally freely in any depth of water and even in air.

In the preferred construction all conductors carrying the electrical current used in operating the mechanism are wound upon the piston-like emitting member, comprising a mass of steel which is in contact with the water and forms a powerful magnet. This tends to prevent overheating and allows smaller sized wire, or greater current strengths, to be used than would otherwise be possible. This feature also increases both efficiency and output as the force on the "armature" wire assists in the operation of the device. Moreover a distinct improvement lies in the arrangement now proposed of a copper tube held within and in contact with a steel tube and oscillating in the narrow annular space between the piston-like magnet and an annular collar of magnetic material in the outer casing. By this construction the air gap and hence the reluctance of the magnetic circuit is reduced and the electrical efficiency of the mechanism greatly augmented. The oscillation is produced electrodynamically by action of the oscillating conductor in a magnetic field and not by electromagnetic reaction.

The invention will be understood by reference to the drawings, in which:—

Figure 1 is a longitudinal section of a device embodying the invention;

Figures 2 and 3 being sections, respectively, on lines 2—2 and 3—3 of Figure 1.

In this figure A is a mass of iron or steel which is moved backward and forward to produce sound waves. Its front surface *a* is in contact with the medium in which the sound waves are to be produced and corresponds with the diaphragm heretofore used in devices of this kind. In order to permit the requisite movement of this steel member A, the thickness of metal is reduced at a^1, this reduction being sufficient to allow the required amplitude of motion of the central rigid portion of the steel piece A. A slot is cut within the steel piece at A^1 in which is wound the requisite number of turns of insulated copper wire B connected with a direct current generator (not shown) to make of the steel piece a powerful electromagnet. On the surface of this steel piece A are wound two connected coils of insulated wire E and F, designed to carry the alternating current used to produce the required movements of the steel member. One end of a tube G of elastic metal is rigidly secured (by bolts for example) coaxially to the inner end of the steel member which is provided with a flange or lugs *g* for this purpose. To the other end of the elastic member G is secured a second tube of elastic material G^1, which tube is arranged coaxially with the first tube and with the steel member A. The tubes G and G^1, which are, for example, of steel, are held together at their inner ends by a spacing member H and two stiffening rings J and K. The tubes, spacer and stiffening rings are held together, without the possibility of lost motion, in any suitable manner. As shown they are riveted together by rivets *h*.

A copper tube L is secured within the free end of the tube of larger diameter G^1 to form an integral portion of that tube. A collar M of magnetic material, such as iron, is held firmly in place around the steel member A and coaxial with it. A tube or pipe N with flanges is bolted to the periphery or flange of the member A and serves to form a portion of a case to contain the entire device. The joints between the tube M and the member A and the head N^1 should be packed to keep out water. The collar M may be attached to the interior of the tube N. A small flat ring *n* is fitted to the tube N and extends across the end of the collar M. The open end of the tube N is closed in by a head N^1 which is bolted thereto and has an opening *n* which may carry a gland (not shown) for the conductors leading from the oscillator to sources of current. There are many kinds of glands suitable for this purpose and they are so well known that further description is unnecessary. The case N together with the head N^1, when the former is bolted to the member A, forms a complete and watertight casing for the mechanism.

When direct current is passed through

the windings B the mass of iron A is magnetized. The lines of force pass radially from the member A through the air gap between the magnetised member and the copper tube L and through the steel tube to which the copper tube L is attached and through the ring of magnetic material M. The result is that there is a strong magnetic field created in the space in which the copper tube is free to move. The connections of the coils E and F, designed to carry the alternating currents, are such that when alternating current passes through them, powerful currents are induced in the copper tube and combine to force the copper tube longitudinally in a direction depending upon the direction of the currents. The reactive forces on the coils E and F also assist in moving the massive member A.

In operation, a direct current is passed through the field winding B and an alternating current, of a frequency equal to the natural frequency of the vibrating system, is passed through the alternating current coils E and F. The alternating current produces an elongation or compression of the elastic members G and G^1 which motion is imparted to the member A tending to force the mass A inward and outward, but with an amplitude of motion relatively much smaller than that of the copper tube. It will be noted that there is no practical limit to the movement of the free end of the copper tube L so that the amplitude of motion can be as great as the material of the tubes G and G^1 and their connections will withstand.

P is a block of insulating material mounted on the member A and carrying the necessary binding posts p, p for the wires which pass up thereto through the passages p^1.

The precise construction shown may of course be modified in various ways evident to a person skilled in the art, while embodying the invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, as communicated to me by my foreign correspondents, I declare that what I claim is:—

1. A sound producing device comprising a rigid sound emitting member, in which the sound emitting member is connected at or towards its periphery to one end of a double tube adapted to transmit longitudinal oscillations, the other end of which tube reciprocates by electrodynamic action in a magnetic field, for the purpose specified.

2. A sound producing device as in Claim 1, in which the second end of the said double tube carries a copper ring which oscillates in the magnetic field.

3. A sound producing device as in Claim 1, in which the sound emitting member is in the form of a massive piston-like body of magnetic material carrying a magnetising coil and connected to a casing by an elastic peripheral flange.

4. A sound producing device as in Claim 3, in which the piston-like member also carries an oscillatory current coil, for the purpose specified.

5. A sound producing device as in Claim 1, in which the sound emitting member is in the form of a massive piston-like body secured in the open end of a casing through an elastic peripheral flange at the outer edge.

6. A sound producing device as in Claim 1, in which the double tube comprises two concentric steel tube elements rigidly connected together at one end with a spacing ring between them.

7. A sound producing device as in Claims 3 and 4, in which the emitting member is surrounded by a stationary ring of magnetic material and the oscillatory tubular conductor moves in a narrow air gap between the magnetised emitting member and the said ring.

8. A sound producing device having its parts constructed, arranged and adapted to operate substantially in the manner hereinbefore described with reference to the example illustrated in the accompanying drawings, for the purpose specified.

Dated this 21st day of June, 1923.

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Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson Ltd.—1924.

[This Drawing is a reproduction of the Original on a reduced scale]

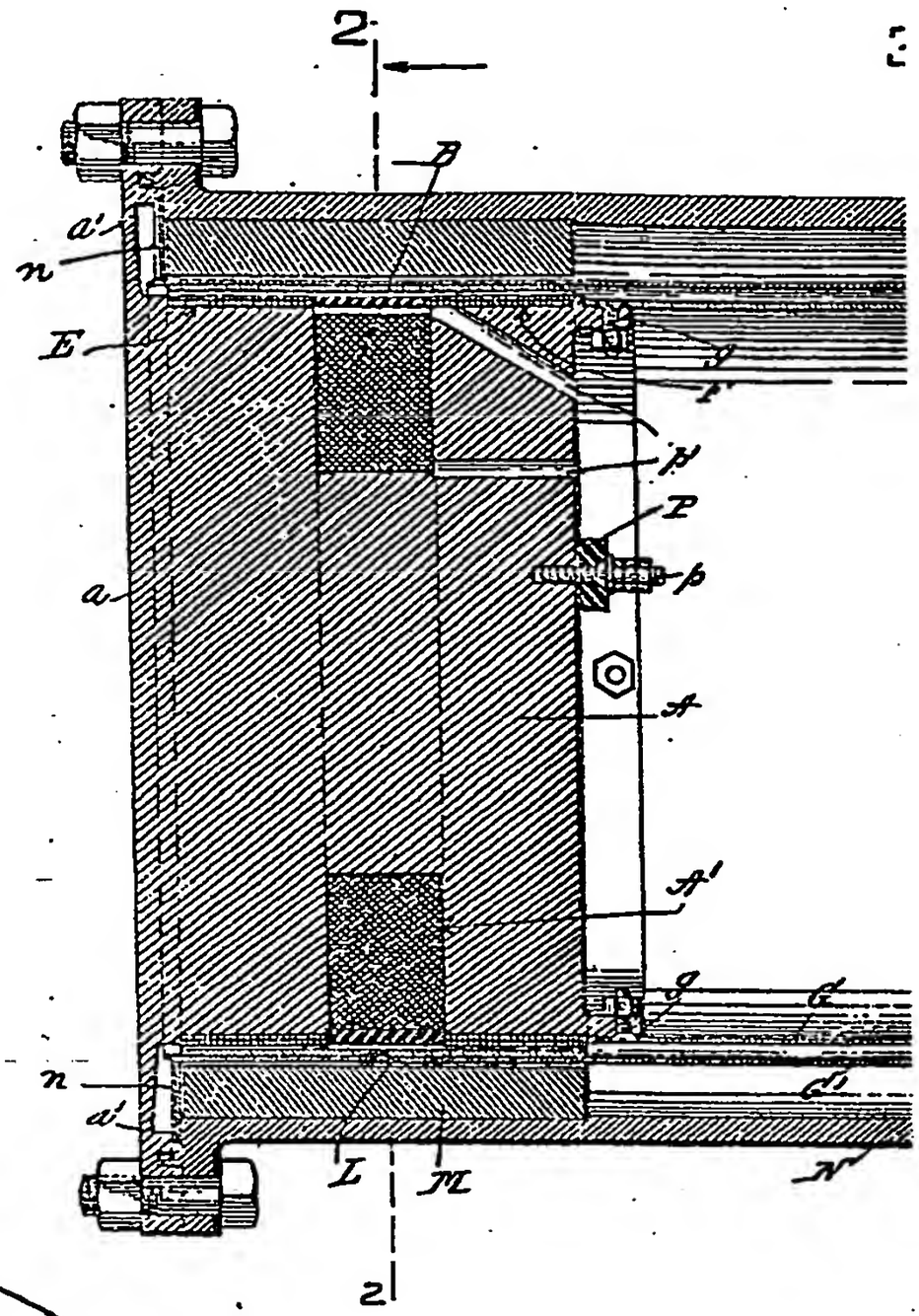

Fig. 2.

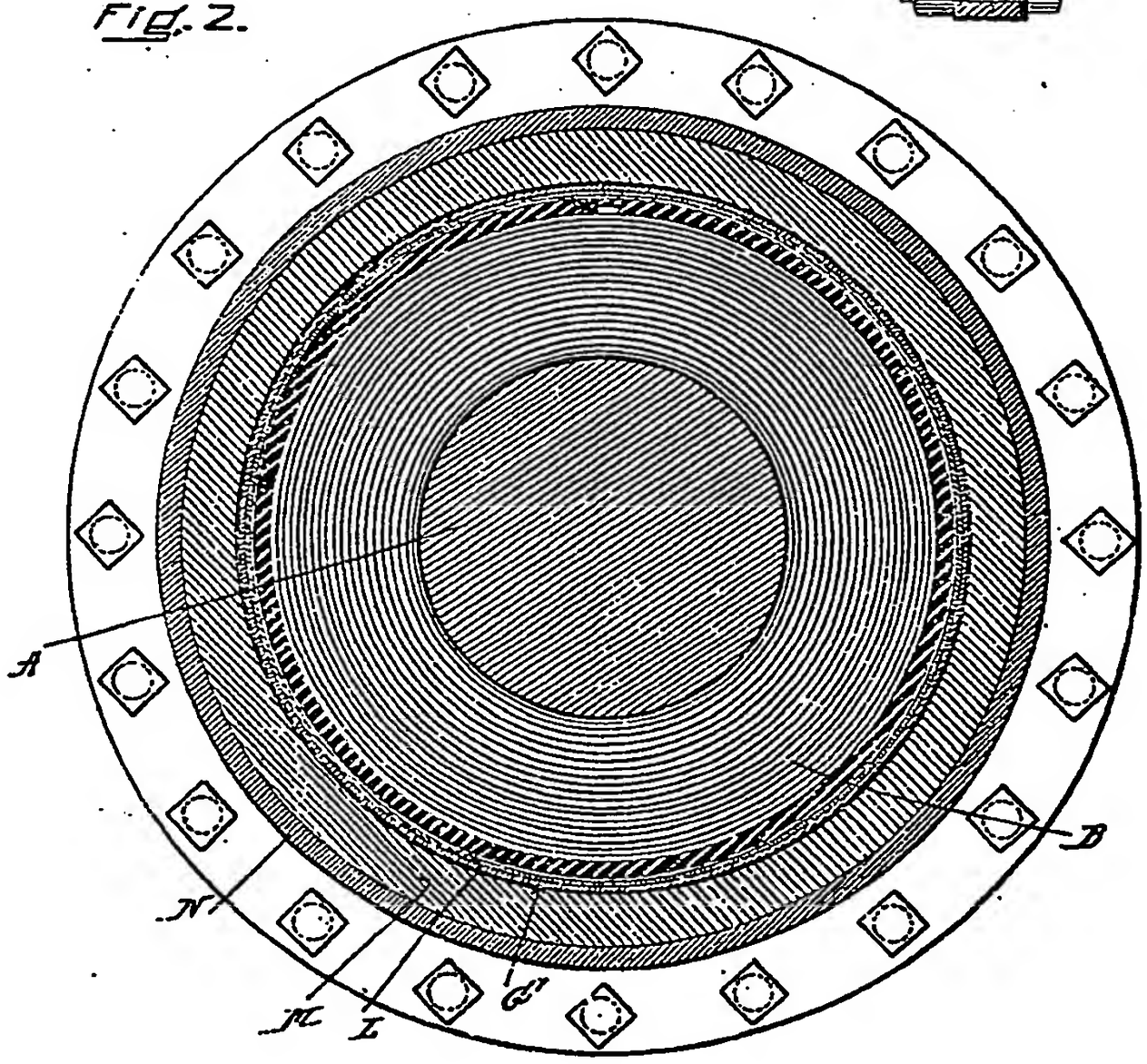

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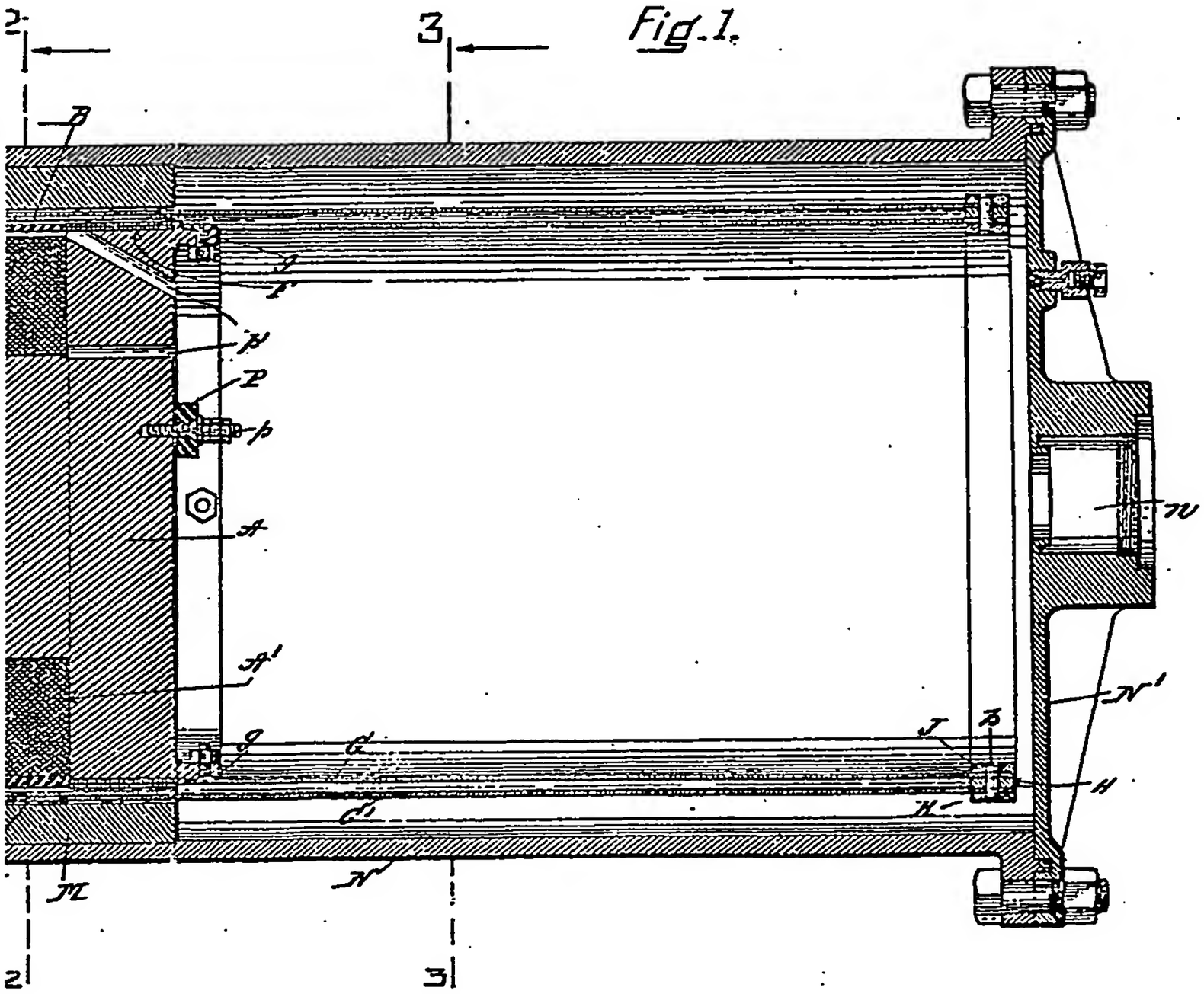
Fig. 1.



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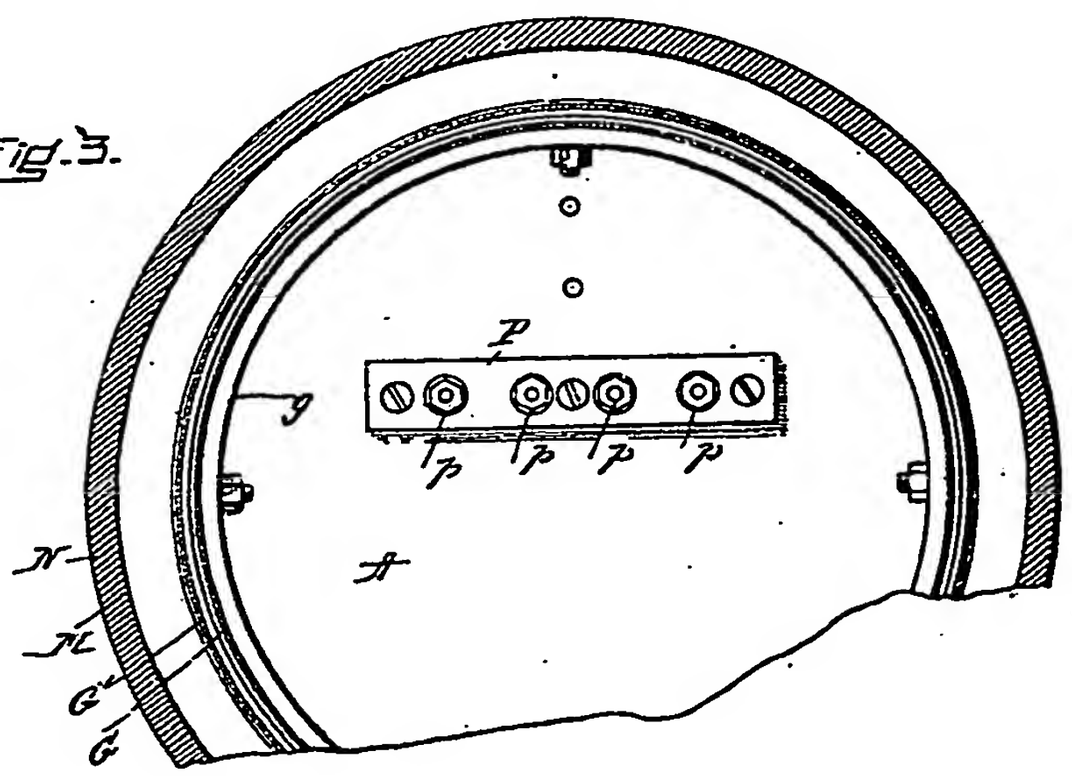

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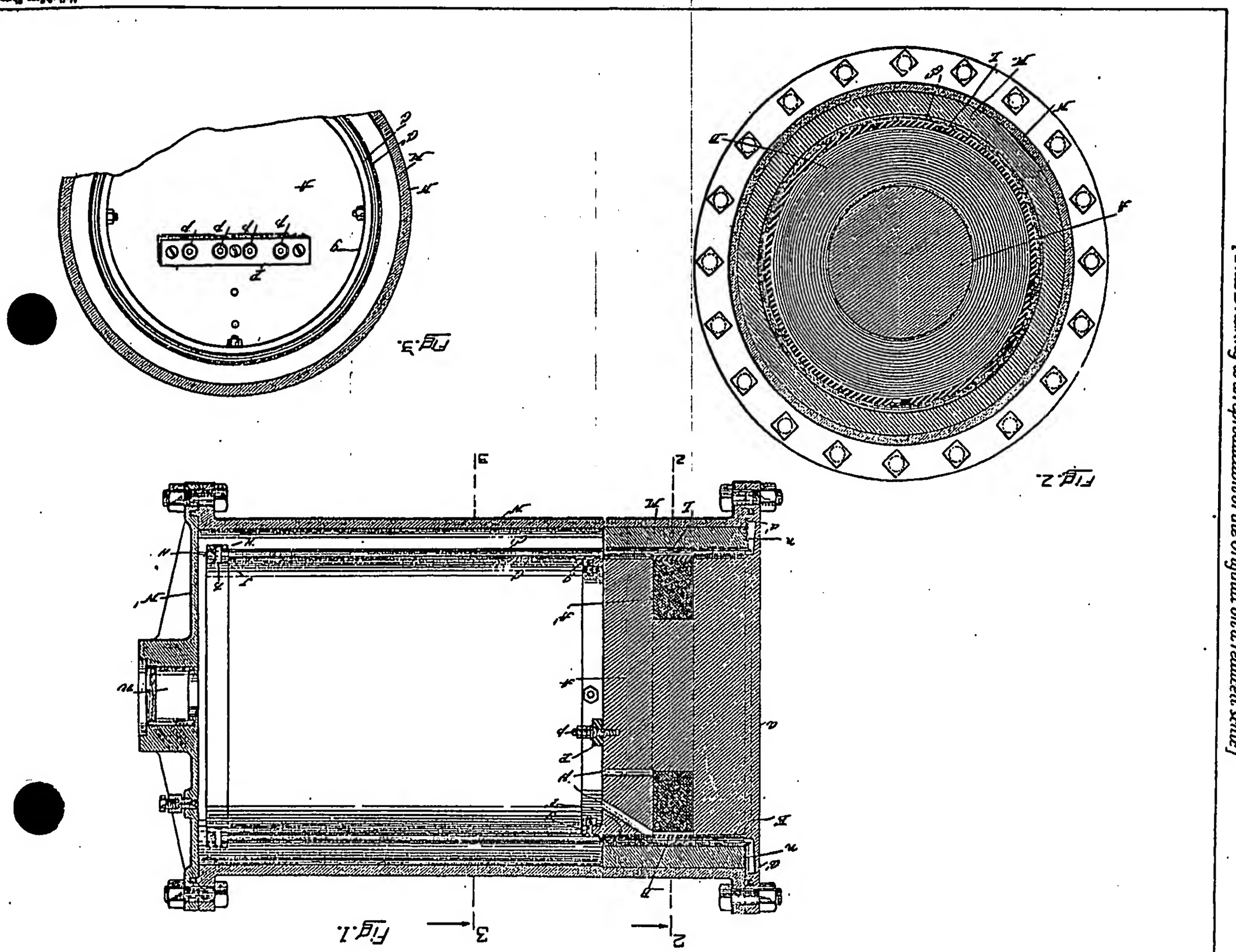

Fig. 1.

Fig. 2.

Fig. 3.

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